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ABSTRACT

This proposal calls on the state of Illinois to initiate a statewide computing and telecommunications network that would give its residents access to higher education, advanced training, and electronic information resources. The proposed network, entitled Illinois Century Network, would link all higher education institutions in the state to elementary and secondary education, public libraries, hospitals, government and government agencies, industry, corporations, small business, and individuals. The proposal envisions a network technology that would allow individuals who cannot attend a university to take courses from home or from their place of employment and at a time of their own choosing, allowing students to study more independently on or off campus. The report discusses the hardware needed, necessary changes in curriculum content, and support staff needs. It estimates capital and operating costs, taking note of the difficulties of using traditional cost-benefit analysis for such a project. Also suggested are three different types of management structure that might be appropriate, and an eight-step strategy for implementing the network. A technical appendix defines a set of goals and principles, discusses technology components, the campus infrastructure, and home access needs. A second appendix breaks out specific cost components. (CH)

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ED 412 805

Illinois Century NETWORK

The Illinois Century Network:

New Dimensions for Education in Illinois

A vision for communications and computing networking
to retain and expand Illinois' position
as a world leader by the turn of the century

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IHE 030 593

Report and first-phase recommendations of the Higher Education Technology Task Force to the Illinois Board of Higher Education and the Illinois Community College Board

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CONTENTS

Membership

Executive Summary

1 **Overview**

3 **The Difference for Education**

5 **What it takes: Hardware**
- Backbone
- Campus connections
- Campus infrastructure
- Special considerations

8 **What it takes: Content**

9 **What it takes: Costs**
- Cost avoidance though cooperation
- Traditional cost-benefit analysis

11 **Managing the Network**
- Managing the backbone
- The organizational entity

12 **Recommendations and Next Steps**

14 **Technical Appendix**
- Backbone
- Campus infrastructure
- Connections from home

17 **Appendix on Costs**

19 **Conclusion**

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EXECUTIVE SUMMARY

Illinois stands at a crossroads. Computing and communications technologies are key to the economic vitality of the state, as to the nation. These technologies will neutralize considerably Illinois' historic advantage of strategic location. But they may also create a new advantage. They may transform access to education by neutralizing as well the limitations that location and constraints of time place on people seeking to learn. The technologies may create a virtual revolution in the quality and flexibility of educational opportunity available throughout the state.

Illinois can boast a solid foundation of technological initiatives in education, including the Illinois State Board of Education Internet project, an interactive video system connecting ten regional networks, and basic Internet connections in higher education. It can boast international leadership in computing research. Yet in the technologically advanced economy of the twenty-first century, Illinois is at risk of losing competitiveness to other states in its ability to deliver higher education, advanced training, and access to the growing global wealth of information services.

Illinois and its educational institutions must make a significant investment to prepare us to take advantage of the technologies that are under development today and will be available in the next two to five years. This report proposes that the State of Illinois initiate the Illinois Century Network as a program of network services at sufficient scale to provide its citizens with essentially universal access to education and information resources at reasonable cost. The Illinois Century Network will link every higher education institution in Illinois to a very high bandwidth network and to elementary and secondary education, public libraries, hospitals, governments, government agencies, industry, corporations, small businesses and individual citizens. It will build upon previous technology investments and in concert with initiatives under way from the Illinois State Board of Education, Central Management Services, the Illinois State Library, and other regional and local networks.

Through these connections, and through a parallel investment in human resources to develop these vast new opportunities, Illinois higher education can address both the quality of traditional education and the rapidly growing need for ongoing, just-in-time training, education from home or workplace or local access site, and exchange of information across all boundaries of distance and time. In an emerging global market for educational services, Illinois can ensure against finding itself a net importer.

Without a structure that stays ahead of needs and is competitive with the deployment in other states, Illinois will not be the locus of job creation or of the kinds of information-age innovation that will create the wealth of the 21st century. Nor will its citizens enjoy the advantages in quality of education and quality of life that will come to those who exploit the potential of this technological revolution.

OVERVIEW

Creative, aggressive use of advanced technology can transform higher education in Illinois by providing two distinct advantages: (1) new, more adaptive media to enhance learning and (2) communications capacity to extend opportunity everywhere in the state. With these advantages, Illinois can sustain its history of benefits reaped from its rich supply of geographic, natural and human resources.

Computing and communications technology and the services that will grow up around them hold a key to the economic vitality of the state, the nation, and the industrialized world. A revolution is well under way in how commerce is conducted, how person-to-person communication occurs, how information is organized and delivered, how teaching and learning are accomplished and how jobs are created. It is a revolution likely to have impact comparable to the combination of the telephone, the jet airplane and satellite broadcasting. It is changing the basic nature of things that depend on location and time. And it will make possible learning scenarios that can hardly be imagined today.

This report proposes that the State of Illinois initiate the Illinois Century Network as a program of network services at sufficient scale to provide its citizens with essentially universal access to education and information resources at reasonable cost. The Illinois Century Network will connect every higher education institution in Illinois to a very high bandwidth network, giving citizens statewide access to higher education, advanced training and the growing global wealth of electronically available material. It will build upon the state's earlier technology investments, integrating them and multiplying their effectiveness as it also provides new, unique capabilities.

We are not talking about higher education operating in isolation. Central to the value of technological advancement will be its ability to link higher education to elementary and secondary education, public libraries, hospitals, governments, government agencies, industry, corporations, small businesses and individual citizens. The Illinois Century Network will build upon the initiatives already under way by the Illinois State Board of Education to deploy a statewide elementary and secondary school network; by the Central Management Services to establish a statewide telecommunications network; by the Illinois State Library to link learners with libraries in Illinois; and by regional and local higher education and community networks springing up across Illinois. Illinois must develop the infrastructure necessary to integrate and coordinate the networking initiatives spearheaded by different public sectors of education because that integration will be crucial to the future success of educational technologies. That success in turn will be crucial to the state's ability to sustain leadership in the quality of its education and to meet the lifelong learning and training needs of a technologically advanced economy.

The advantages to be reaped are: a well-educated citizenry in all parts of the state; a highly trained and easily re-trainable workforce; rapid and easy access to new information and discoveries; learning and delivery of information made flexible and interactive; time and travel saved; the potential for collaboration and partnership unimpeded by geographic distance; and options opened up throughout the state that would normally be available only in metropolitan areas.

In the last year, we have seen exponential growth in several states' support of advanced technology for delivery of education. Wisconsin has announced a major program called Technology for Educational Achievement which mandates that $200 million be infused into Wisconsin's universities, technical colleges and elementary and secondary schools, part of it earmarked for teaching educators how to use the technology effectively in and beyond the classroom. The University of California at Berkeley now offers more than 180 courses over the Internet, the State University of New York has established the SUNY Learning Network, and Pennsylvania State University offers courses through the Penn State World Campus. The Western Governors Association founded the Western Governors University, a degree-granting "virtual" university, with support from 15 western states and drawing upon the full range of the states' educational institutions. Governor Mike Leavitt of Utah, who has been a leader in this effort, commented recently, "With the Western Governors University, we are creating a global, free market for educational services, delivered to any location at any time. Information and the opportunity to gain knowledge are beginning to flow to where the people are—at home, at work, or on the road."

In this global free market for educational services, Illinois cannot afford to become a net importer. Statewide commitment and support of advanced information and communications technologies are critical to ensure that Illinois citizens have the access they need to participate in education, to run their businesses and to enhance their personal lives. Access to the technology we need won't come cheaply, but the cost of not moving forward will be higher and longer-term.

To compete, we have to start with a robust, flexible network for higher education itself. Because the rate of innovation and deployment is so rapid and so capital intensive, it is important that government assist the educational system in adapting this new technological approach to realizing and expanding its traditional missions. Illinois needs to add information-age services that are beyond what is routinely available from the telecommunications industry and beyond the normal budget capabilities of educational institutions. We must think and invest aggressively just to stay ahead of states that have traditionally been far behind us but that are now making significant strategic investments in information technology in support of their educational systems.

This report will describe what current technology can do for us and what evolving technol-

ogy will be able to do in the near future. It will outline the requirements for a forward-looking, flexible infrastructure to realize these possibilities; discuss needs for content development and training of personnel; estimate initial and continuing costs in equipment and support; suggest models for management of the network to be created; and recommend next steps.

THE DIFFERENCE FOR EDUCATION

Campuses, with their classrooms, lounges, and cafes, allow students to communicate with faculty and with each other; their libraries provide books and access to electronically stored information; their laboratories make it possible to learn through experiment and to test theory. Books display text and graphical information. CD-ROMs add video, sound and planned interaction (such as the rotation of an image or practice tests with instant correction). Broadcast TV reaches a large audience at distance. Interactive video allows that audience to respond. We can speak to each other in pairs or groups over the telephone and we can send written materials and limited graphics by fax.

The Internet allows us to combine the advantages of all these media and to overcome the limitations of any of them on its own. Anything on the Internet can be updated rapidly, at relatively low cost to the producer and no cost to the receiver. It can transmit voice, data, graphics and video, though the last is still limited by network bandwidth requirements. It can reach a large audience or a small one, and the audience can respond and interact. It can be used to communicate to and from any place and any number of places, with participants involved at the same time or responding on their own times to others' messages. Its capacities for information and communication can be put to remarkable use both on campuses and at distance.

Network technology will allow individuals who are unable to reside on or near a university or college campus, or who have constraints on their schedules, to take courses or seek information from their home or place of employment and often at hours of their choosing. It will allow workers to update their job skills with just-in-time training. The American Society for Training and Development anticipates that by the year 2000, 75% of the current workforce will need retraining just to keep up.

Network technology will enable students to study more independently, on or off campus, and to interact more frequently with faculty and other students. It will allow students access to classes, courses and programs of study under circumstances in which today the required relocation or commuting is difficult, costly, or impossible. It will enable colleges and universities to give advice or technical assistance to entrepreneurs, farmers, health professionals and others at vast savings of time compared to today's efforts.

Network technology can bring the best in electronic visualization, simulation, laboratory instrumentation, and other learning tools available at a few universities, libraries, museums and companies, to the myriad other learning venues throughout Illinois. It can reach resources such as art objects from museums around the world, virtual operating rooms and engineering design studios, music performances, and massive amounts of information. It can enable the student sitting at a personal computer at a community college or at home to engage the Mars landing or visualize the development of a thunderstorm in the same way as students at a research university. It can provide faculty with tools to demonstrate the form and location of bonds within a molecule, and then to leave the demonstration online for students to review later. It can give students the tools to collaborate on learning projects, access digital libraries, and interact with others regardless of distance or time.

Whether enrolled with a community college, a public university, or private higher education, or independently seeking just-in-time information on a single problem, citizens of Illinois can use this technology to gain access to educational materials, work-setting simulations, newly breaking world events and interactive computer applications. From the homemaker in Elgin who wants to take courses at her local community college when her children are asleep at night, to the employee who needs training at the workplace on the newest computer-assisted drafting software, to the undergraduate on campus exploring a unique library collection across the country or collaborating with another student at 2 a.m., the Illinois Century Network will open education throughout the state to everyone, at any place and any time.

Thanks to this same capacity for access, the Network will also enable powerful collaboration among the state's higher education institutions and beyond. Professional development for faculty, shared curriculum and course design, and partnerships which offer joint on-line courses and programs are a few of the possibilities. Partnerships with high schools can enhance the exchange of data and video, create new mentoring opportunities, or support student teacher internships. Partnerships with corporations will make possible access from the workplace to highly tailored training and continuing education programs offered by colleges and universities anywhere in the state.

With the growing importance of lifelong learning, this flexibility, accessibility and freedom from the constraints to time and geography become increasingly valuable. We need the Network both to enhance the quality of education and to make it ubiquitous, serving all the people of Illinois throughout their lives.

The primary access to these services will be from educational sites including local elementary and secondary schools, community colleges, colleges and universities, and libraries. Providers of the educational content will be traditional educational institutions at the outset, but will rapidly grow to include publishers, for-profit educators, and others. The rapidity of

growth should not be underestimated. Until as recently as four years ago, for example, the Internet had only a minor impact on higher education, even though its history reaches back to the late sixties. In 1993 the release of NCSA Mosaic (developed in Illinois) and the emergence of commercial Internet service providers changed its course, with profound effects on its potential for education. The accelerated development of network tools and applications over the last few years has transformed the Internet into an unparalleled medium for communication and information delivery. Today, with 51 million people in the U.S. on line, unlimited Internet access from home or office costing as little as $19.95 per month and personal computers with Pentium processors available for less than $1000, we can anticipate growing access from the living room and workplace as well as educational and other public or commercial venues.

The rapid course of change and the critical role that technically skilled workers will play in the competition for jobs will demand a strong technical infrastructure. Without a structure that stays ahead of needs and is competitive with the deployment in other states, Illinois will not be the locus of job creation or of the kinds of information-age innovation that will create the wealth of the 21st century. Thus it may be prudent to view a powerful technology to some degree as an end in itself for the next decade. It is going to be the fundamental tool which allows radical change to occur and we want a rich soup for innovations to occur in.

These are the steps being taken in most states, and Illinois should be aggressive enough with the quality and distribution of these services to have a competitive advantage. We have an opportunity to create a new form of natural resource that we know will be useful beyond our present ability to predict. Today's children will be very much prepared to make the most of these capabilities. Like the children of the 60s, 70s, and 80s who were shaped by television in how they learn and what they study, the children of the 90s are being shaped in their expectations of learning by the computer. Already there are ten-year-olds who think of the computer as an appliance as indispensable as the toaster and who go to the computer and the Internet as their primary information and entertainment source. To a large degree, what they become and what they make of the State and our society will be framed by these new technologies, technologies that seem natural to them.

WHAT IT TAKES: HARDWARE

It is useful to think of the infrastructure or physical network in segments: the central backbone; the campus or local connection to the backbone; and the campus or local infrastructure, including personal computers, local area networks connecting those computers, servers and classroom technology. All are required for access.

Backbone

The backbone of a network is the portion that covers the longest distances. It is a resource shared by all who connect to it and must support the full range of services they require. The backbone is a high performance part of the network, and its reliability is critical. A direct counterpart to the backbone is the long distance circuits and telco switches currently operated by the long distance portion of the telephone industry. Local phone companies connect to this backbone so that their customers can make calls outside the local area.

With the backbone at adequate capacity and at the leading edge of functionality, any individual institution can use new technological capabilities as soon as it is ready. This potential cannot exist without a shared backbone with advanced technical standards. The commercial Internet will always lag in deploying advanced features, waiting until they are reasonably mature. This backbone is a critical element in reaching our goal of competitive advantage for Illinois institutions.

More detail on the governing principles and architecture of the backbone appears in the Technical Appendix to this report.

Campus Connections

Colleges and universities have already invested heavily in early generations of networking, in both campus networks and basic connectivity to the Internet. Under a National Science Foundation program, over 100 Illinois institutions received grants for their initial Internet connections. Basic connections are, therefore, no longer a pressing issue for most of higher education. (The same is not true for elementary and secondary schools, where fewer than half have connections or local networks.)

But this initial generation of connections supported traffic primarily in the form of text. As images became more dominant in the traffic, the capacity requirements increased dramatically. As we convert from still images to moving pictures and sound, they increase again. It is these more recent capabilities that have multiplied the power of the Internet as an educational medium, and Illinois does not have statewide the level of network connectivity necessary to seize these opportunities. The Intenet2 project is likely to provide federal support only to the major research universities and for some educational experiments. Broader availability of this advanced technology will be primarily the responsibility of institutions and their regular sources of funding. The Illinois Century Network would meet this responsibility for Illinois institutions.

Campus Infrastructure

To participate fully in the opportunities the network backbone and new technologies open up, academic institutions must have modern and plentiful campus networks and

access to personal computers. The more complex applications will run only on current machines with good displays, large memories, and fast network connections.

For the state to reap full advantage of its network investments, it should recognize a set of minimum standards of computing and communications capability for institutions of higher education. Institutions of higher education should need no more special justification for seeking to achieve these levels than they do today for telephones or photocopiers. This report will recommend that a follow-on survey be undertaken to determine the extent of the collective gap between these standards (described in the Technical Appendix) and current capabilities of public institutions, from which an estimate of the total cost of meeting the standards can be made.

Special Considerations

KEEPING UP TO DATE

We plan in the face of a rapidly changing technology base for the communications industry, made more uncertain by the change in industry structure resulting from the deregulation legislation of 1996 and compounded by the rapid convergence of Internet technology, video and telephony. The plan must incorporate both an initial technology direction and a process for keeping the operational program up to date. Some preliminary parameters for the initial direction are included in the Technical Appendix. An ongoing technical planning group will be needed to deal with the issues of when to adopt new technology and how to support it.

GEOGRAPHICALLY ISOLATED LOCATIONS

An initial task for the technical planning group will be to decide how to reach the more isolated locations that depend on small telephone companies with older distribution systems that do not have high-speed facilities available at any price. A statewide group can aggregate its purchasing power either to require the deployment of comparable facilities or to find a partner for high-speed wireless systems. Cooperation with the Illinois State Board of Education and the University of Illinois Cooperative Extension Service, which need services in every area of the state, may prove useful in this effort.

EXISTING STRENGTH IN VIDEO

Another initial task will be to develop a plan to integrate the existing video facilities with Internet service. Significant investments in technology, particularly in interactive video, have been made and will contribute to the full capacity of the Illinois Century Network as we approach an era of full integration of voice, data and video.

WHAT IT TAKES: CONTENT

The Illinois Century Network will make possible a curriculum that is dynamically updated, a learning environment that emphasizes the interaction of the learner with the subject matter, and teaching that brings together teachers and learners regardless of time or geography— but only if that curriculum and that learning environment are developed. If the three basic principles of real estate are location, location and location, the three basic principles of the Internet are content, content and content. Simulations of hazardous or dangerous tasks, training programs for complicated procedures and sophisticated equipment, complex data sets, three-dimensional views of works of art and of objects of the physical world, and even the more ordinary transpositions of classroom curricula or exercises, don't just appear on the computer: people have to put them there. When others put them there (much as others write and publish textbooks), teachers and support staff need to gather and adapt them to their courses, programs and purposes.

Content is more than curriculum and more than information resources. It is also the full range of student support services, which once on the network will be more conveniently available to students both on campus and off. These services include admission, financial aid, advising, academic records and transcripts, tutoring, placement and proficiency testing, and services to students with disabilities.

Institutions will require support staff adequate to operate their facilities and to assist faculty in the use of technology. Institutions with minimal technical staffing will need a support structure organized around others with more personnel. This structure should include both full support for those who prefer not to develop their own and training programs for those who do. Tasks include training faculty and providing technical assistance in curriculum development, operating information servers, advising on campus infrastructure design, and staffing help-desks to assist end users.

Faculty as well will have to take time and effort to incorporate the new technologies, for their classes on campus as well as at distance. The Illinois Century Network should be accompanied by a funding strategy to support development of courses using emerging technologies and to disseminate successful efforts. In addition to assisting faculty with known applications, it is important to keep pushing the boundaries of how emerging technology can improve education. Therefore the funding strategy should also support pilot projects for new, prototype applications. From ecological models demonstrating the complicated interaction of man-made chemicals with nature, to the use of collaborative technologies to bring our communities together, there is great potential for Illinois citizens to learn and work in new, more effective ways.

One of the great advantages of Internet-based communications is timeliness. Another is

agility. Without them, we will not use the network to its full powers and we will put ourselves at a crippling disadvantage. It is therefore critical that campuses and coordinating boards alike ensure that their policies, especially for program development and authorization, support rather than impede efforts to meet educational needs. We will need flexibility and efficient processes to exploit the new potential and to remain competitive in the national and international market that is developing.

WHAT IT TAKES: COSTS

The Internet has often been compared to the interstate highways and other road systems of the country, but there are two important differences. First, even though the cost of running wires and fiber optics is relatively low compared to building roads, and thus makes it practical to go long distances and reach sparsely populated areas, the fact that communications is largely a private- sector business means that the high-profit areas with dense populations of commerce will be the first to be served. Second, while roads are seen as a public good and supported through a combination of general taxes and taxes related to use, the tradition for communications services is to put the whole burden on either the end user or some institutional intermediary such as a school or public library. One consequence of these two circumstances is that early adopters of advanced services, and especially those in remote locations, face prices that are likely to be beyond their means. A second is that with early demand developing only in rich market areas, the industry will deploy services only in those areas.

To overcome the market forces that would otherwise limit the use of advanced technology in much of the state of Illinois, and to limit geographic location as a major factor in the communications costs that different public institutions must bear, the Illinois Century Network should be a major undertaking of the state.

In brief, the costs are estimated at $405,000,000 in capital costs over five years, at $109,000,000 for each of the first three years and $39,000,000 for the fourth and fifth years. This estimate includes building the backbone; connecting both public and private institutions of higher education to the backbone; and, for public institutions only, on-campus network costs and campus hardware such as personal computers and servers. Operating costs, also for public institutions only, include managing the backbone and connections to it; technical support staff on the campuses; and staff training and content development. These are estimated at $14,500,000 in the first year, rising to $29,500,000 by the third year and then remaining stable.

Details of these estimates, their flexibility and the assumptions that underlie them are provided in the Appendix on Costs to this report.

Cost Avoidance though Cooperation

The ability of this project to work with other parts of the public sector is already established. Meetings have been held with the Illinois State Board of Education, the University of Illinois Cooperative Extension Service, the State Library and Central Management Services. In every case there is a desire to avoid duplication and to have the best possible coverage of the state. There are no obvious barriers to achieving this cooperation.

One of the major possible benefits of cooperation between higher education and the Illinois State Board of Education is the discount structure on communications services available to elementary and secondary systems through the Universal Access program mandated in the deregulation legislation of 1996. By sharing the wide area backbone we can gain substantial benefits.

A recently completed study by consultants for Central Management Services has suggested they move in the same technical directions as this report recommends. The Illinois Century Network would expect to work closely with Central Management Services and at a minimum to take advantage of their contracting and volume pricing.

Traditional Cost-Benefit Analysis

Traditional cost-benefit analysis depends on costs and benefits both being narrowly defined. Such approaches should be applied to a project like the Illinois Century Network with caution. For example, traditionally one might compare the cost of two college degree programs by taking the benefit to be the delivery of instruction and the costs to be the costs of that delivery. The Illinois Board of Higher Education conducts extensive, comparative cost studies of this sort for programs across Illinois public institutions. But if one keeps in mind that every under-served student is potentially an under-productive employee, the definition of benefit broadens. The benefit is not simply the delivery of a program, but what the student saves in costs and time of travel, and what the student may do in consequence, such as acquire the skills and credentials to move from a low-paid part-time job to a well-paid full-time career. The gain is not in a lowered cost of production but in a heightened benefit, but the benefit is diffused and not recovered by the producer.

Nor is formal education the only benefit of enhanced networking capabilities in the state. The general public will expect services and resources to be made available through these networking capabilities. Workforce development initiatives such as one-stop Illinois Education to Career (IETC) centers and workforce training can be provided via statewide networking. Local, state, and national government can be linked together for access to the latest changes in areas such as legislation and licensure requirements. Other examples of public and community benefits include: information access to libraries, governmental labs, and college and university services; direct service to Illinois agriculture via the University

of Illinois Cooperative Extension Services; and the ability to share specialized information among health care providers, university hospitals and medical research centers.

The citizens of Illinois will come to expect ubiquitous access to all the resources supported by the network of advanced information and communications technologies— what the Eastern District of the Pennsylvania Circuit Court called "the most participatory form of mass speech yet developed." Economic development efforts by local municipalities, as well as on a state level, will be enhanced by the capabilities provided by this network. It is for such broad social benefits that other states are creating educational networks and working with communications companies to position themselves for the future.

MANAGING THE NETWORK

Managing the Backbone

There are three generic types of management arrangement for a statewide network:

1. Highly centralized: Either a state authority or state-recognized not-for-profit corporation is authorized to act on behalf of broad higher education or public sector interests and to manage the networking and video activities, possibly including operational responsibility. In this model financial incentives are essential to widespread participation. Examples of this model are netIllinois, the Illinois Library Computer Systems Organization and some Central Management Services activities.

2. Highly decentralized: Each institution is largely autonomous, although the state can influence behavior through financial support of preferred forms of participation. In this model business flows to service providers on the basis of individual decisions and the system depends on the commercial providers to assure quality of service. There is no authority to guarantee any uniformity in network services and strong financial incentives are required to achieve common goals.

3. Centralized support with local choice: A form of state authority or state-recognized not-for-profit corporation arranges a selection of attractive contracts for major service components, but each institution chooses the level of service it wants. Central Management Services provides many services in this way, including some where it serves an operational role as well.

To create a competitive advantage for Illinois, provide a high level of service independent of location within the state, and enable the facilities to be shared with other Illinois public sector programs, the model of centralized support with local choice is preferred. With substantial effort devoted to a good selection of service contracts to buy and with some

central funding to overcome differences in location and resources, it can do a good job of making high-performance services available. Operating with sufficient scale, it can create pricing models that overcome some of the disadvantages of location and encourage vendors to provide advanced services on a relatively aggressive timetable. Within this model there are many variations, and decisions to be made with regard to governance, organizational form, and degree of operational activity.

The Organizational Entity

Management of the network includes setting standards, channeling funds, dealing with service providers or serving as a provider, monitoring engineering and performance, deciding on when to adopt new technology and how to support it, and establishing any necessary business practices. The entity that provides the centralized management must meet the following characteristics. Their combination may require a formation unique in Illinois:

- It must be institution neutral.
- It must be able to recognize the great diversity of missions and current technical capabilities of the institutions to be served and provide assistance to them.
- It must be independent in order to facilitate decision-making.
- It must include individuals who represent colleges, universities and the public.
- It must be able to work in cooperation with the communications activities of other state sectors, including Central Management Services, the Illinois State Board of Education, the University of Illinois Cooperative Extension Service and the State Library.
- It must have the regard of the executive and legislative branches of state government and access to them.
- It must be funded as a line within the State budget.
- It must have the ability to enter into contracts, accept grants, and hold assets.
- It must have the agility to respond to rapidly changing requirements and opportunities.

RECOMMENDATIONS AND NEXT STEPS

1. The State of Illinois should initiate the Illinois Century Network as a program of network services at sufficient scale to provide its citizens with essentially universal access to education and information resources at reasonable cost.

2. The State should initiate discussions with the telecommunications industry in order to foster cooperation with them and use of their standards, and to plan for the use of commercially available services to the extent technically and financially feasible.

3. The Illinois Century Network should leverage previous state and institutional investments in video and networking equipment.

4. The Illinois Century Network should be developed in cooperation with other Illinois public sector communications projects and avoid duplication of costly facilities and support. In particular, development should proceed in consultation with the Illinois State Board of Education, the State Library, the University of Illinois Cooperative Extension Service, the Illinois Library Computer Systems Organization and Central Management Services. Coordination with the Illinois State Board of Education is essential.

5. The State should recognize a baseline computing and communications capability for institutions of higher education. The Illinois Board of Higher Education and the Illinois Community College Board should sponsor a survey to determine the extent of the collective gap between current communications capabilities of public institutions and the standards for campus capabilities set forth in the Technical Appendix to this report, and make recommendations accordingly. Helping public campuses below the baseline who wish to reach it to do so should become a priority.

6. The State of Illinois should create a statewide organization to fund and manage the Illinois Century Network. The organization should be designed to take the management responsibilities and meet the organizational criteria described in this report.
    - The State should establish a small working group to investigate the organizational issues and recommend a structure.
    - The State should establish a small working group to prepare a full cost estimate for the Illinois Century Network, including costs indicated in recommendations 7 and 8 below.

7. A technical planning group of the most skilled staff available should be established in advance of the management organization to:
    - prepare a requirements statement for the backbone and serve as technical advisors for its procurement
    - address the issue of how to reach isolated locations with limited communications access, drawing upon existing Central Management Services knowledge
    - develop a plan to integrate the existing video facilities
    - develop a plan to integrate the Illinois State Board of Education network and other existing public sector facilities with the Illinois Century Network
8. The Illinois Board of Higher Education and the Illinois Community College Board should prepare a funding strategy to:
    - support development of courses using emerging technologies
    - support collaborative efforts by institutions made possible by these technologies
    - disseminate successful efforts

- support pilot projects of new, prototype applications

This strategy must address both the training of faculty and students and the employment of staff at the campuses to manage campus facilities and to support curricular development.

TECHNICAL APPENDIX

The plan for the infrastructure or physical network is governed by a set of goals or principles:

- The system should both accommodate known applications and stimulate the creation of new ones.
- The system should offer a competitive advantage for Illinois providers of education, both on campuses and at distance.
- Every institution in the Illinois higher education system should have adequate communications facilities to originate and to be a delivery site for distance education.
- Geographic location should not be a major factor in the communications cost burden that public institutions must bear.
- The plan should foster cooperation with the communications industry and use emerging standards in that industry. To the extent technically and financially reasonable, it should use commercially available services.
- The plan should leverage previous state and institutional investments in video and networking equipment.
- The plan should foster cooperation with other Illinois public sector communications projects and avoid duplication of costly facilities and support.
- The plan should be effective even for institutions without high levels of technical staff expertise.

Backbone

To make this project both economical and efficient we should create a statewide backbone of very high capacity, to which local connections can be made at reasonable cost. This backbone would carry traffic to all regions of the state and provide the connections to the international network service providers who would be contracted to deliver our traffic beyond Illinois. The backbone will consist of local "points of presence" (PoPs) distributed around the state which are the switching centers and points of connection to local circuits from client institutions, and the high speed circuits which connect these PoPs together. The PoPs will have a set of circuits interconnecting them in a pattern related to the volumes of traffic. This architecture is the normal way that the telephone industry has operated. It is also the same model that has been begun by the Illinois State Board of Education, and these wide-area efforts should be merged rather than duplicated.

There are basically two options in relating the state network to the telephone industry. In both options the circuits are provided by the industry, but in one the state contracts with the industry to own and operate the PoPs, and in the other a state organization owns and operates them. The first is generally termed working within the public network and the latter is considered a private network. Because the commercial Internet service providers are focused on meeting rapid expansion of demand for existing services, it is likely that the Illinois Century Network will require a private network to stay competitive with other states. It is possible that the State will be able to convince an industry partner to play a primary role, using the Illinois Century Network as a prototype for the future, in parallel with their commercial offerings.

This report calls for a high-performance backbone. Because both the technology and applications demands are changing rapidly, the term "high performance" requires constant revision. In 1986 the national backbone operated at 56,000 bits per second, or the capability to move four pages of text per second. This was the backbone shared among thousands of users, and is roughly equivalent to today's best telephone modem for a single user at home. At that time, a backbone of 1.5 million bits per second (Mbps) was the high-performance goal, and it was achieved in the late 1980s. Soon that was overloaded and considered slow, particularly as applications began to move from simple text to multi-media. The 1994 move of the backbone to 45 Mbps was again hailed as high performance, but again has come to be considered slow as more complex images and low quality video begin to dominate the traffic. The goal for 1998 is to reach 600 Mbps and to increase greatly the number of circuits.

The initial goal for the Illinois Century Network is to have the main backbone at a mixture of 155 and 622 Mbps and to expect each higher education institution to choose its local connection at 45 or 155 Mbps. The backbone portion will grow rapidly as educational applications increase and institutions prepare to upgrade their connections.

Several trends in the communications industry seem well established. The use of fiber optic based transmission for long distance, high volume traffic is well under way but will not reach every small town for a number of years. As fiber becomes the standard, the conversion to digital communications follows rapidly. The performance levels of communications systems then begin to track the explosive growth rates we have seen in the computer industry. Engineering marvels affect fiber transmission capacities as they affected the microprocessors ability to handle data. Thus within major metropolitan areas and for major parts of the wide area, there is an obvious technical direction driven by the plans and investments of the industry. These include fiber plant, SONET and ATM as low-level communications protocols, and Internet protocols at the higher levels.

Campus Infrastructure

The State should recognize a baseline computing and communications capability for institutions of higher education. Helping public campuses below the baseline who wish to reach it to do so should become a priority. Much higher standards are appropriate for some institutions:

- student access to a networked personal computer provided on the campus near where the course is taught at a rate of one quarter hour a week per credit hour taken. This should increase to one half hour by FY2000.
- personal computers accessible to students, replaced on a cycle of no longer than five years
- dial-in access for students who own computers, provided by the campus, the state organization, or commercial Internet service providers if available, at less than $20 per month
- one networked personal computer per faculty office, replaced on a cycle of no longer than five years
- fifteen percent of classrooms equipped with an instructor's networked personal computer and suitable projection. These should be replaced on a cycle of no longer than three years. This standard should rise to fifty percent by FY2002.
- Internet access of 45 Mbps or greater, with the capability to devote part of the bandwidth to traditional video distribution and reception
- video organization and classrooms for incoming distance education

In order to move towards more graphical Internet content and wider availability of video, including multiple concurrent channels to or from a site, we have chosen the industry standard of 45 Mbps DS-3 as the minimum campus connection. This can support the concurrent data and video forms the state has already invested in and allows a convenient path for the integrated services that will become standard in a few years. It also puts all of higher education on the technology base used by the higher speed circuits that the research universities already employ and that will soon reach wide use.

Connections from Home

The home access part of the Internet is currently the modem operating over a telephone line. Through this the user connects either to a campus service or to an Internet service provider. Typically these connections provide speeds of about 28 kpbs, with some newer modems operating at somewhat higher speeds. Internet service providers are now reaching many rural areas with only a local phone call required, but the quality of the telephone wiring frequently reduces the actual speed to well below the theoretical speed. Even at their best, modems are limited in the quality of video they can support.

It is expected that improved alternatives to modems will be available in the near future.

Both wireless services and some based on cable television distribution will provide performance adequate to support the multimedia educational material that we currently can provide only within campus networks. As these services become available from the commercial communications industry, the Illinois Century Network can serve to establish favorable master contracts for students and faculty at home.

APPENDIX ON COSTS

There are essentially six elements of cost:

1) capital costs of the Illinois Century Network backbone
2) capital costs of campus connections to the backbone
3) capital costs of (a) connections and (b) hardware within the campuses
4) operating costs for managing (a) the backbone and (b) connections to it
5) operating costs of hardware and connections within the campuses
6) operating costs for support staff, training and content development on the campuses

Capital and operating costs for the backbone (items 1 and 4a), including the necessary switching, circuits, Internet traffic charges and support, are estimated at $75,000,000 over five years. The additional capital and operating costs of connecting campuses to the backbone (items 2 and 4b) are probably another $75,000,000 over five years. The total for this portion is thus $150,000,000 over five years, or approximately $30,000,000 a year. These numbers assume full coverage of these costs by the State and include connections to both public and private institutions of higher education.

At this stage of planning, these cost estimates are subject to considerable uncertainty in the circuit prices, which account for about 60% of the total estimate. The estimate is relatively conservative, but can be achieved if the full project is implemented. If the project is done on a smaller scale, or without coordination of purchases, circuit costs may be much closer to list prices.

Circuit costs, though they can be treated as capital (and are here), are ongoing costs and will continue so long as the network is maintained, at roughly $20,000,000. With time, however, we can expect the local portions of these ongoing costs (roughly $9,000,000) gradually to be absorbed into institutional budgets.

No assumptions are made here as to the share of these costs that will be a campus responsibility at either public or private institutions. The project will be implemented on a universal scale only if the state provides new funding for the majority of the costs of both campus connections and the backbone. Under such circumstances, the telecommunications

industry can be expected to be a significant partner through both reducing prices to the levels assumed in this estimate and deploying facilities to reach those parts of the state that currently do not have what is necessary for the levels of service this report specifies.

It is anticipated that the backbone will be shared with the Illinois State Board of Education networking initiative, and that some other costs will also be shared. These pooled resources will help keep the equipment up to date and capacities matched with demand.

Capital costs for the third element, campus networking (item 3a), are estimated at $210,000,000 for public institutions only, which might be deployed at a rate of $70,000,000 a year over three years. To include personal computers or servers (item 3b) with any degree of precision, the results of the survey described in recommendation 5 of this report are needed. A rough figure is $80,000,000. Such funds might best be awarded through grant programs managed by the Illinois Board of Higher Education and the Illinois Community College Board.

For items 5 and 6, at public institutions only, recurring operating costs for network support staff are estimated at $7,500,000; for personal computer support at another $7,500,000; and for content development expert staff at $7,500,000 again. This total of $22,500,000 could be phased in over a three-year period and might be shared with the campuses in varying degrees. It is assumed that costs of faculty time for development of content would be borne by the campuses and/or supported through grant programs from the Illinois Board of Higher Education and the Illinois Community College Board.

Summary (numbers reference list of cost elements above)

		Year 1	Year 2	Year 3	Year 4	Year 5	Total
Capital	(1)	$ 12M	$ 12M	$ 12M	$ 12M	$ 12M	$ 60M
Capital	(2)	11M	11M	11M	11M	11M	55M
Capital	(3a)	70M	70M	70M	-----	-----	210M
Capital	(3b)	16M	16M	16M	16M	16M	80M
Capital	total	$109M	$109M	$109M	$39M	$39M	$405M
Operating	(4a)	$ 3M	$ 3M	$ 3M	$ 3M	$ 3M	n/a
Operating	(4b)	4M	4M	4M	4M	4M	
Operating	(5–6)	7.5M	15M	22.5M	22.5M	22.5M	
Operating	total	$14.5M	$22M	$29.5M	$29.5M	$29.5M	

CONCLUSION

Information and communications technologies are becoming an integral part of every person's life. In the next decade they will be more and more important as a means for all of us to continue learning, formally and informally, throughout our lifetimes. For the betterment of all the citizens of Illinois, it is incumbent upon Illinois educational institutions to provide these opportunities for all of us as we move into the next century. Only the State of Illinois can ensure that we do so.